



CE Workgroup

Embedded Linux Community Update

May 2019

Tim Bird

Sr. Staff Software Engineer, Sony Electronics

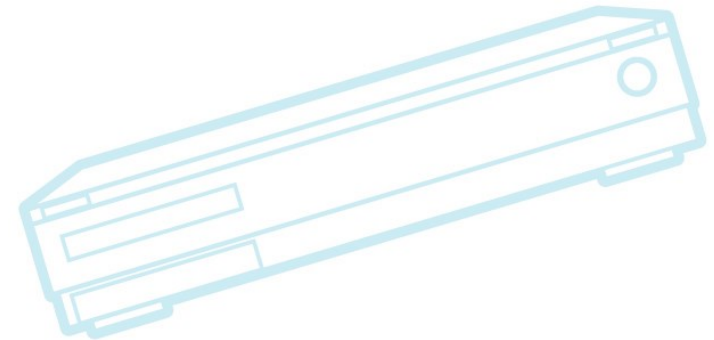
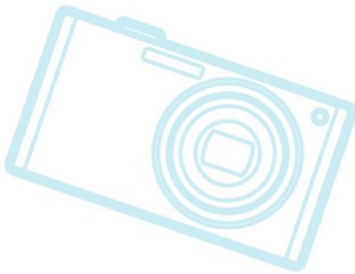
Linux Foundation Technical Advisory Board member



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Nature of this talk...

- Quick overview of lots of embedded topics
- A springboard for further research
 - If you see something interesting, you have a link or something to search for
- Not comprehensive!
 - Just stuff that I saw





CE Workgroup

Outline

OSS Areas
Linux Kernel
Technology Areas
Conferences
Industry News
Resources



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Outline

OSS Areas

Linux Kernel

Technology Areas

Conferences

Industry News

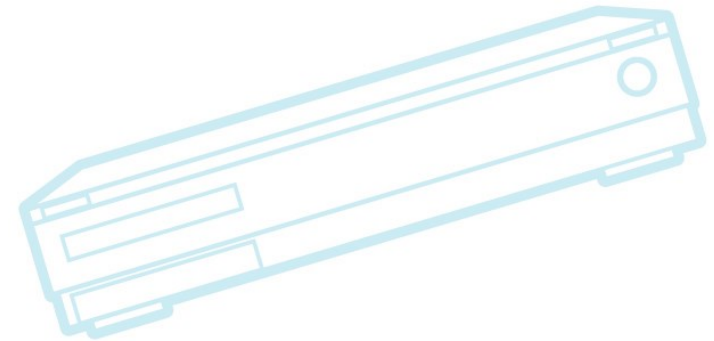
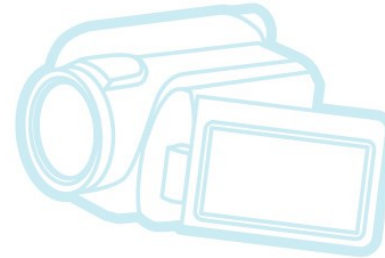
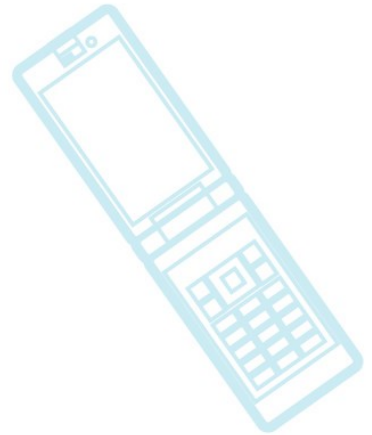
Resources



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Open Source Areas

- Operating Systems
 - Including Linux
- Technology areas
 - Audio
 - Graphics
 - Kernel Coding
 - Languages
 - Networking
 - Security
 - Testing

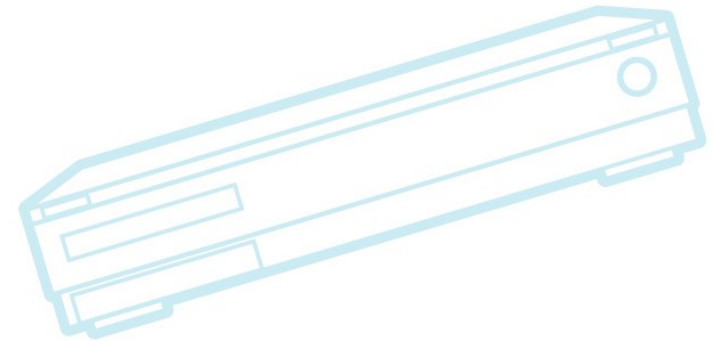
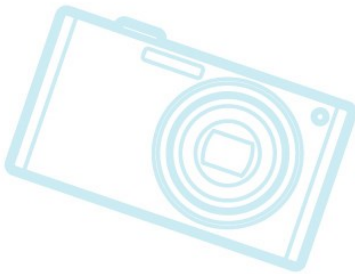
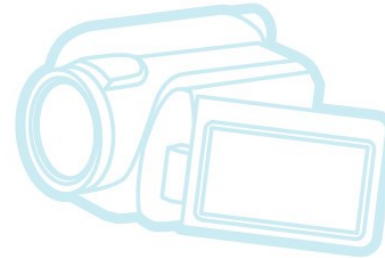
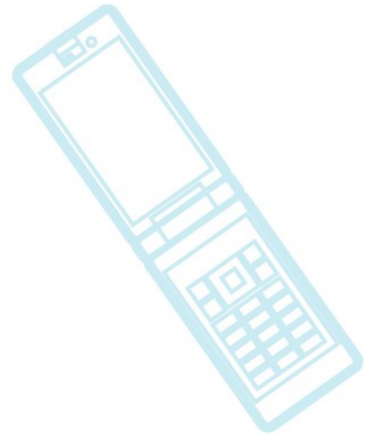




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Operating Systems

- NuttX
- Zephyr
- Android
- Linux





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NuttX

- Working on first-ever conference
- International NuttX Workshop
 - Gouda, The Netherlands, July 16-17
 - Sponsored by Technolution
 - Sony and NXP are involved
 - About 70 attendees
- Nuttx YouTube channel:
 - <https://www.youtube.com/channel/UC0QcillcUnjJkL5yJJBmluw>
 - Has intros and tutorials and descriptions of features



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Zephyr

- Couldn't find much recent news
- Gains Memory Protection (March 2018)
 - <https://www.electronicdesign.com/embedded-revolution/zephyr-iot-os-gains-memory-protection>
- Support for POSIX APIs
 - Docs describes config option: `CONFIG_POSIX_APIS`
 - I have no idea how complete it is
 - Docs just say: "Enables mostly-standards-compliant implementations of various POSIX (IEEE 1003.1) APIs."



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Android

- Third beta for Android 10 ('Q' version) was released on May 7, 2019
 - Probably a final release in August
- Some features:
 - Dark mode
 - Floating settings panel
 - Dynamic depth format for photos
 - Google pushing new photo file format that encodes depth
 - AV1, H.265 and Opus codecs
 - Support for foldable phones
 - "Bubbles" multi-tasking feature



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Kernel Versions

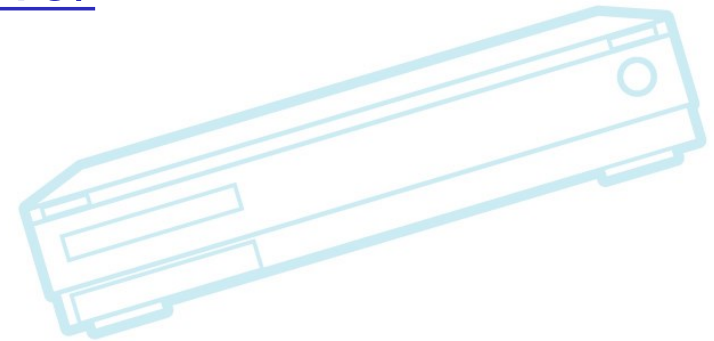
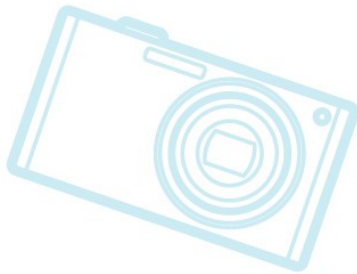
- Linux v4.18 – 12 Aug 2018 – 70 days
- Linux v4.19 – 22 Oct 2018 – 71 days
 - Author: Greg Kroah-Hartman
- Linux v4.20 – 23 Dec 2018 – 62 days
- Linux v5.0 – 3 Mar 2019 – 71 days
- Linux v5.1 – 5 May 2019 – 63 days
- Current kernel = v5.2-rc1



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Linux 4.18

- Power domains now support active state management
 - Instead of enable/disable, can now handle different idle states (continuum of operation)
 - <https://lwn.net/Articles/744047/>
- bpfilter user mode helper system
 - <https://lwn.net/Articles/755919/>





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bpfilter user mode helper

- Complicated mechanism to:
 - compile user space code
 - from the Linux source tree
 - bundled in a kernel loadable module file (.ko)
 - with execution initiated from kernel space
- Used to provide support for backwards compatibility with netfilter configuration protocol
 - user-space 'program' to compile netfilter config protocol into bpf pseudo-code
- As a mechanism, may lead to all kinds of crazy stuff



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Linux 4.19

- L1TF mitigation (a variant of meltdown)
 - <https://lwn.net/Articles/762570/>
 - The fun continues...
- time-based packet transmission
 - Allows a program to schedule data for transmission in the future
 - <https://lwn.net/Articles/748879/>
- EROFS – enhanced read-only filesystem
 - High-performance
 - Good for certain embedded situations
 - (in staging)



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Linux 4.19 (cont.)

- Block I/O latency controller
 - Regulates latency instead of bandwidth
 - See <https://lwn.net/Articles/758963/>
- Common Applications Kept Enhanced (CAKE) packet queuing discipline
 - For devices behind consumer-level routers on relatively slow broadband links
 - Avoids bufferbloat, shapes traffic, etc.
 - See <https://lwn.net/Articles/758353/>



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Linux 4.19 (cont.)

- New asynchronous polling interface
 - Yet another API, not a replacement for existing APIs
 - <https://lwn.net/Articles/743714/>
 - https://kernelnewbies.org/Linux_4.19#New_asynchronous_I.2FO_polling_interface



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Linux 4.20

- XArray data structure
 - A reworking of the radix tree structure, with better APIs
 - Provides a normal API and advanced API
 - The page cache has been converted to use it
 - <https://lwn.net/Articles/745073/>
 - <https://linuxplumbersconf.org/event/2/contributions/259/>
- PCI subsystem support of peer-to-peer DMA operations between peripherals (P2PDMA)
 - <https://lwn.net/Articles/767281/>



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Linux 4.20 (cont.)

- Many block drivers converted to multiqueue API
 - Plan to remove the legacy API in the next development cycle
 - <https://lwn.net/Articles/552904/>



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Linux v5.0

- Energy-aware scheduling
- Finished 64-bit version of syscalls with time fields
 - For year-2038 improvements
- Legacy block layer IO scheduler removed
- Binderfs – backward-compatible filesystem for Android's binder IPC mechanism
- Adiantum crypto module



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Linux v5.0 (cont.)

- JSON schemas for device-tree bindings
 - <https://lwn.net/Articles/771621/>
- Dynamic events interface to tracing subsystem



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Linux v5.1

- Finally deprecating support for a.out binaries
 - https://www.phoronix.com/scan.php?page=news_item&px=Linux-Dropping-A.Out
- Lots of DRM changes
 - https://www.phoronix.com/scan.php?page=news_item&px=Linux-5.1-DRM-Changes
- More Y2038 work
 - More syscalls with 64-bit time values
 - See <https://git.kernel.org/pub/scm/linux/kernel/git/torvalds/linux.git/commit/?id=b1b988a6a035> for a list of new syscalls (20 of them)



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Linux v5.1 (cont.)

- New sysctl knob (kernel/sched_energy_aware)
 - To enable/disable EAS
- Also, new documents on energy-aware scheduling
 - Documentation/scheduler/sched-energy.txt
 - Documentation/power/energy-model.txt
- Improved idle behavior in tickless systems
 - Added timer-events oriented (TEO) CPU-idle governor
 - Uses timer interrupts timing instead of device interrupt timing for predicting next wake-up
 - See <https://lwn.net/Articles/775618/>



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Linux v5.1 (cont1.)

- Modification to memfd for Android use case
 - Add `F_SEAL_FUTURE_WRITE` operation for memfd regions
 - Caller can continue to write to region, but others can't
 - Want to eliminate use of ashmem (legacy Android memory manager)
- F2FS has a new mode bit that disables copy-on-write behavior for a file (`F2FS_NOCOW_FL`)



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Linux v5.2

- ext4 supports case-insensitive lookups
- New system calls for filesystem mounting
 - See <https://lwn.net/Articles/759499/>
- Support for ARM Mali GPUS (more later)
- Support for Fieldbus protocol
- New “mitigations=” command-line option to control speculative execution features
- Improved support for gcc ‘-Wimplicit-fallthrough’
- Lots of BPF improvements



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Linux v5.2 (cont.)

- Pressure stall monitors added
 - Allow user-space to detect and respond quickly to memory pressure
 - Monitor can open `/proc/pressure/memory` and write a stall notification specification
 - indicates to the kernel what frequency to check for stalls (which can be as little as .5 seconds)
 - Monitor can then use `poll()` to receive stall notification events
 - Android can use the functionality to detect mounting memory pressure and kill processes before the device becomes sluggish
 - See <https://lwn.net/Articles/775971/>



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Contributions for recent kernels

Version	Changesets	Lines	Developers
4.15	14,866		
4.16	13,630		
4.17	13,541		
4.18	13,283		
4.19	14,043		
4.20	13,884	+686K / -319K	1743
5.0	12,517	+582K / -334K	1712
5.1	12,749	+545K / -289K	1707
5.2	12,204 (so far)	+590K / -389K	1584* (??)

Source: <https://lwn.net/Articles/780271>



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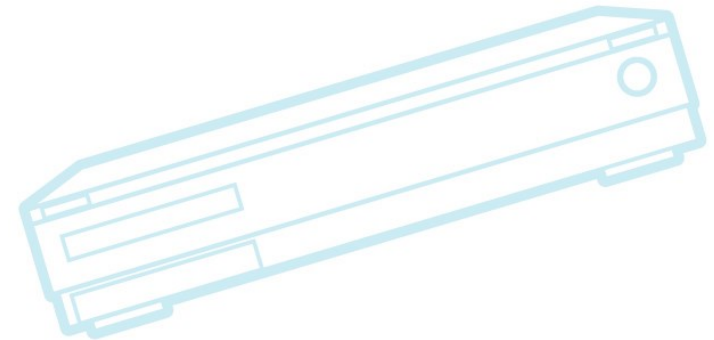
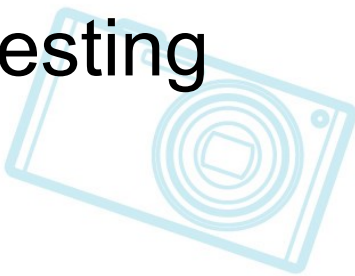
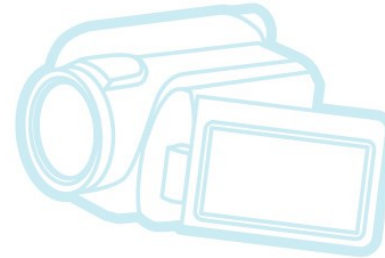
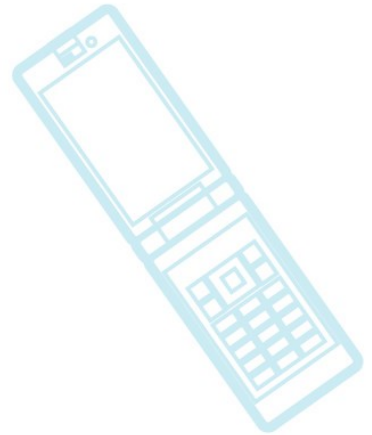
Resources



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Technology Areas

- Audio
- Graphics
- Kernel coding
- Languages
- Networking
- Security
- Testing





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Audio

- Sound Open Firmware
 - Project by Intel and Google to support Open Source firmware for audio IP blocks
 - Announced at ELC 2018
 - Support mainlined in v5.2 kernel (latest merge window)
 - See <https://lwn.net/Articles/749888/>
 - Information at: <https://www.alsa-project.org/main/index.php/Firmware>



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Graphics

- Support for Open Source MALI drivers upstream
 - Added in v5.2
 - Lima for older GPUs
 - Panfrost for recent ones
 - See <https://www.collabora.com/news-and-blog/blog/2019/03/04/panfrost-update-new-kernel-driver/>
- Android is finally using DRM/KMS
 - Moved off their own Atomic Display Framework
 - Google Pixel 3 using DRM Atomic Modeset and Explicit Synchronization (relatively new Linux DRM/KMS features)
 - See <https://www.collabora.com/news-and-blog/blog/2018/12/17/a-dream-come-true-android-finally-using-drm/kms/>



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Kernel coding

- Support for –Wimplicit-fallthrough
 - Warns about possible switch statement error (missing break in a case block)
 - Used to make switch statements more robust
 - See <https://dzone.com/articles/implicit-fallthrough-in-gcc-7> for info about gcc feature
 - v5.2 has marked locations where one case in a switch statement can fall through to the next case
 - Extensive analysis of kernel – only 32 out of 2311 cases remain to be fixed
 - Once complete, can turn on warning by default and catch fall-through errors in newly submitted code



Kernel coding (cont.)

- BPF continues to mature
 - BPF is now well-defined and solving real problems
 - Allows users to alter kernel execution
 - But under control of BPF verifier
 - Example: There's no support for loops
 - See <https://lwn.net/Articles/787856/>
- BPF improvements in v5.2
 - Much faster program verifier (x20 in some cases)
 - Expanded size limit from 4K to 1M instructions
 - BPF program can access global data
 - Can control changes to sysctl knobs



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Languages (Python)

- Python has become dominant in Machine Learning and AI
 - See <https://www.analyticsindiamag.com/5-reasons-why-python-is-the-dominant-language-for-machine-learning/>
- Growing in popularity
 - <https://www.zdnet.com/article/which-programming-languages-are-most-popular-and-what-does-that-even-mean/>



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Languages (C/C++)

- gcc 9
 - Removal of Cell Broadband Engine SPU support
 - New '-flive-patching' flag
 - Lots of diagnostics improvements
 - Can show line numbers in diagnostic source code
 - Can show source code region labels
 - Can output diagnostic information in json format
 - Optimization improvements
 - New options for profile-driven optimization
 - Link-time optimization (LTO) improvements
 - See <https://gcc.gnu.org/gcc-9/changes.html>



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Languages (C/C++ cont.)

- LLVM 8.0 released
 - Features:
 - Speculative Load Hardening (for Spectre issues)
 - Branch Target Identification (for Spectre issues)
 - Improved code diagnostics
 - https://www.phoronix.com/scan.php?page=news_item&px=LLVM-Clang-8.0-Branch-Next-Week



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Networking

- WiFi 6 (802.11.ax)
 - Sub-system support added to v4.19
 - <https://www.linux.com/blog/2018/10/linux-kernel-419-long-term-support-usb-type-c-and-wifi-6>
 - https://www.phoronix.com/scan.php?page=news_item&px=Intel-802.11ax-WiFi-Linux-4.19
- FieldBus support
 - Industrial network for real-time distributed control
 - Added to v5.2



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Security

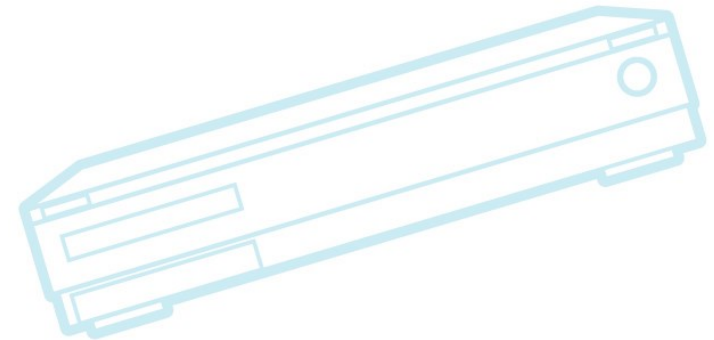
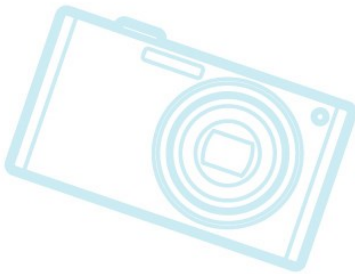
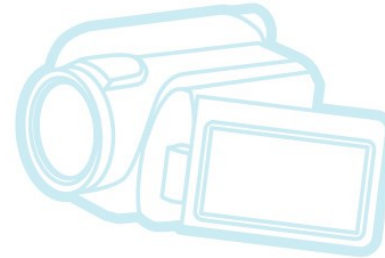
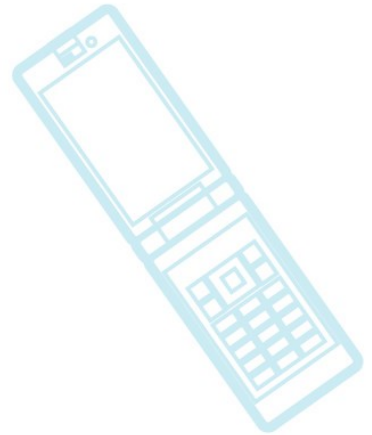
- Adiantum lightweight crypto algorithm added in v5.0
 - Disk encryption for low-end hardware
 - See <https://www.linuxjournal.com/content/disk-encryption-low-end-hardware>
 - Replaced controversial Speck algorithm
 - See <https://lwn.net/Articles/776721/>
 - White paper on Adiantum is available (heavy math and cryptography stuff)
 - See <https://eprint.iacr.org/2018/720.pdf>
- Different approaches to security in Zephyr and Fuchsia
 - <http://linuxgizmos.com/zephyr-and-fuchsia-take-different-paths-to-security/>



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Testing

- Kselftest
- Fuego
- KernelCI
- Kunit test framework





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Kselftest

- Sub-system test code inside kernel source tree
 - Is the preferred place for syscall compatibility/regression tests (over LTP)
- Recent work:
 - More tests and test fixes
 - bpf, spectrum-2, timers, net, netfilter, tls, and more
- See <https://lwn.net/Articles/737893>



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Fuego

- Test Framework for collaborating on tests and test infrastructure for Linux
- v1.4 released Jan 2019
- v1.5 in development
 - Support for distributed testing
 - Test server is included in container
 - Changes in batch testing (for more flexible test pipelines)
 - Increased separation from Jenkins
 - Output support for Squad
 - Integration with other systems:
 - Ability to run Linaro tests in Fuego, or Fuego tests in LAVA
 - Demonstrated at Linaro Connect



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KernelCI

- Support for auto-bisection
- Adding functional tests (not just build and boot)
 - Graphics: IGT (DRM/KMS)
 - Media: v4l2 compliance
 - Power: suspend/resume
 - USB: smoke test
- Working to be a Linux Foundation project
 - Still looking for enough founding member
- https://fosdem.org/2019/schedule/event/kernelci_a_new_dawn/



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Kunit test framework

- Set of patches for kernel unit testing
 - **Not accepted yet**, but under serious review
- Allows writing tests for individual functions
- Tests run in a standalone environment (not in a running kernel) in UML
 - Doesn't support cross-compilation (**does it?**)
- <https://www.linuxjournal.com/content/unit-testing-linux-kernel>
- <https://lwn.net/Articles/780985/>



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CE Workgroup

Conferences (past)

- ELC Europe 2018
 - October 22-24, Edinburgh, Scotland
- Automated Testing Summit
 - October 25, Edinburgh, Scotland
 - https://elinux.org/ATS_2018_Minutes
- Linaro Connect
 - April 1-5, Bangkok, Thailand
 - Personally:
 - Lots of good testing meetings
 - See my keynote: <https://youtu.be/v6NP2LKnG-0?t=1686>



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Conferences - 2019

- Open Source Summit Japan/Automotive Linux Summit
 - July 17-19 , Tokyo, Japan
- Embedded Linux Conference 2019
 - **August** 21-23, San Diego, California, USA
- Linux Plumbers
 - September 9-11, Lisbon, Portugal
- ELC Europe 2019
 - October 28-30, Lyon, France
- Automated Testing Summit 2019
 - October 31, Lyon, France



Automated Testing Summit

October 31, 2019 | Lyon, France, Lyon Convention Centre

The Automated Testing Summit (ATS) is a new technical conference for companies and developers doing automated testing of Open Source products, particularly Linux-based products and services. It is dedicated to sharing knowledge, techniques, and standards for Open Source Quality Assurance. The main organizer of ATS is the Core Embedded Linux Project of the Linux Foundation.





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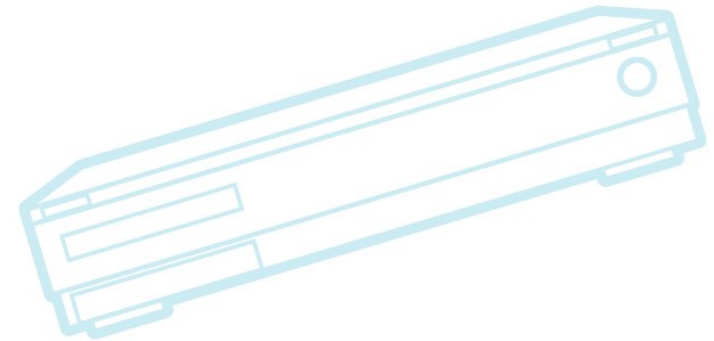
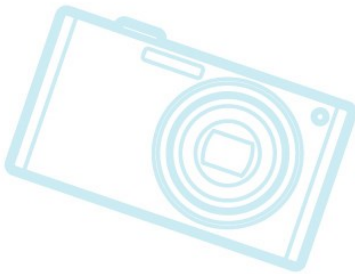
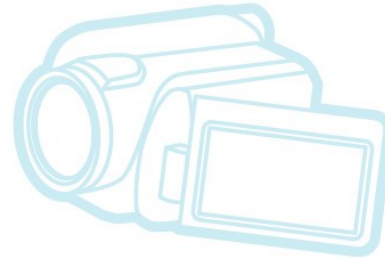
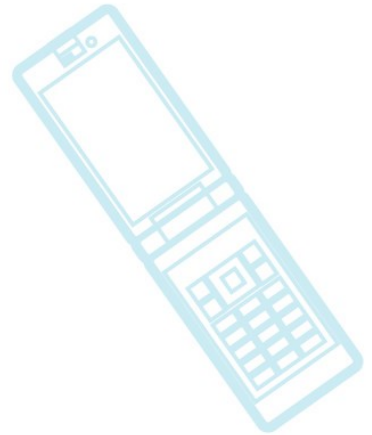
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Industry News

- Trade associations
- Industry changes
- Linux adoption

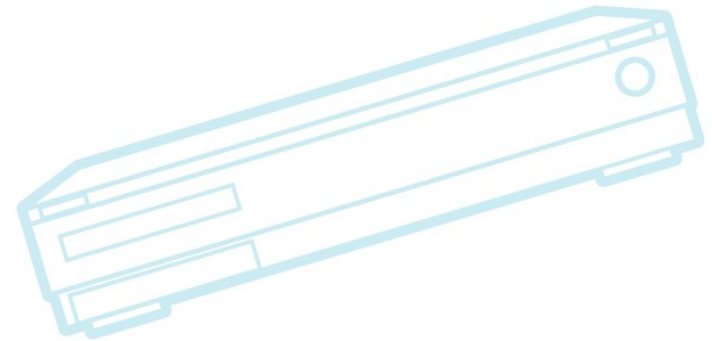
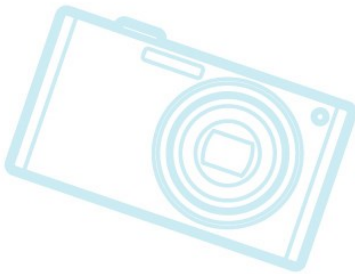
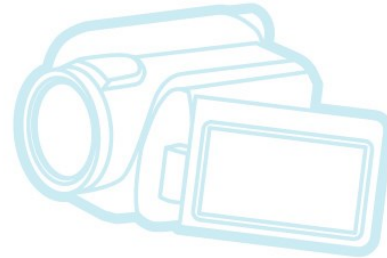
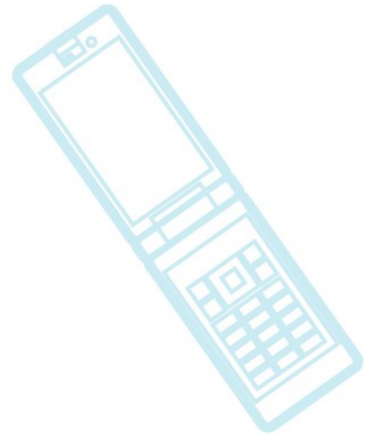




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Trade associations

- Linux Foundation
 - ELISA safety-critical project
 - CIP SLTS release
 - LF Edge
 - AGL





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ELISA

- LF launches ELISA safety-critical project
 - Piggybacking on previous work by OSADL (which Linutronix was heavily involved with)
 - Not much there yet – see <https://elisa.tech/>
 - See <https://www.linuxfoundation.org/press-release/2019/02/the-linux-foundation-launches-elisa-project-enabling-linux-in-safety-critical-systems/>



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CIP (Civil Infrastructure Platform)

- Announces New Super Long Term Support Kernel
 - Advances Automation, Machine Learning and Artificial Intelligence
 - 4.19 kernel
 - See <https://www.cip-project.org/announcement/2019/02/25/civil-infrastructure-platform-announces-new-super-long-term-support-kernel-that-advances-automation-machine-learning-and-artificial-intelligence>
- CIP Also created a new security workgroup



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LF Edge

- LF Edge = Umbrella organization for edge computing (IoT and other)
- Previous projects:
 - Akraino Edge Stack - telecom-oriented
 - EdgeX Foundry - Industrial IoT middleware
- Adds 2 new projects:
 - Project EVE - virtualization engine for deploying containers for industrial edge computers
 - Focused on top-down IoT orchestration
 - EVE = Edge Virtualization Engine (from Zededa)
 - See <http://linuxgizmos.com/project-eve-a-cloud-native-vision-for-edge-computing/>
 - Home Edge (by Samsung)
 - For home edge computing - not sure of details
 - Has discovery, protocols, etc, in addition to home device control and deep learning (boxes on their diagram)



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AGL

- AGL=Automotive Grade Linux
- Released version 7 – March 1
 - Includes voice recognition/speech APIs
 - <https://www.automotivelinux.org/announcements/2019/03/01/automotive-grade-linux-releases-open-source-speech-recognition-apis>
- Hyundai joins AGL
 - <https://www.linux.com/blog/2019/1/hyundai-joins-agl-and-other-automotive-news-ces>
- Volkswagen joins AGL
 - <https://www.automotivelinux.org/announcements/2019/04/08/volkswagen-joins-agl>



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Industry changes

- Microsoft continues to embed and support Linux
 - WSL 2 support for Linux in Windows 10
 - (WSL=Windows Subsystem for Linux)
 - Microsoft ships Linux kernel with Windows!!
 - <https://www.geekwire.com/2019/together-last-microsoft-will-ship-linux-kernel-windows/>
 - <https://www.tasnimnews.com/en/news/2019/05/07/2006153/microsoft-to-ship-full-linux-kernel-in-windows-10>
 - Azure support for Linux guests
 - <https://docs.microsoft.com/en-us/azure/virtual-machines/linux/endorsed-distros>



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Linux Adoption

- Government of South Korea switching from Windows to Linux
 - Windows 7 end-of-life prompted switch to Linux
 - Reasons:
 - To reduce long-term costs
 - To avoid Windows 10 which sends information to Microsoft
 - See <https://www.techradar.com/news/south-korea-moves-from-windows-to-linux>



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Year of the Linux desktop?

- Chrome getting native Linux app support:
 - <https://venturebeat.com/2018/05/08/chrome-os-is-getting-linux-app-support/>
- Windows 10 shipping with Linux kernel
- Mark Shuttleworth says Linux on Desktop “failed”
 - <https://www.tfir.io/2019/05/15/why-linux-on-desktop-failed-mark-shuttleworth/>
 - Maybe he’s just talking about Ubuntu



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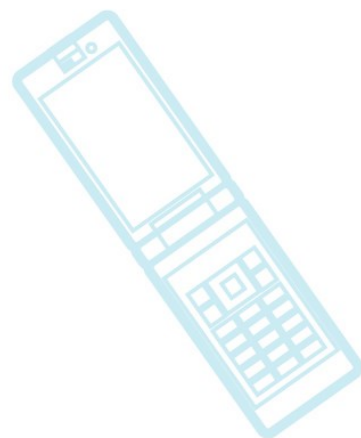
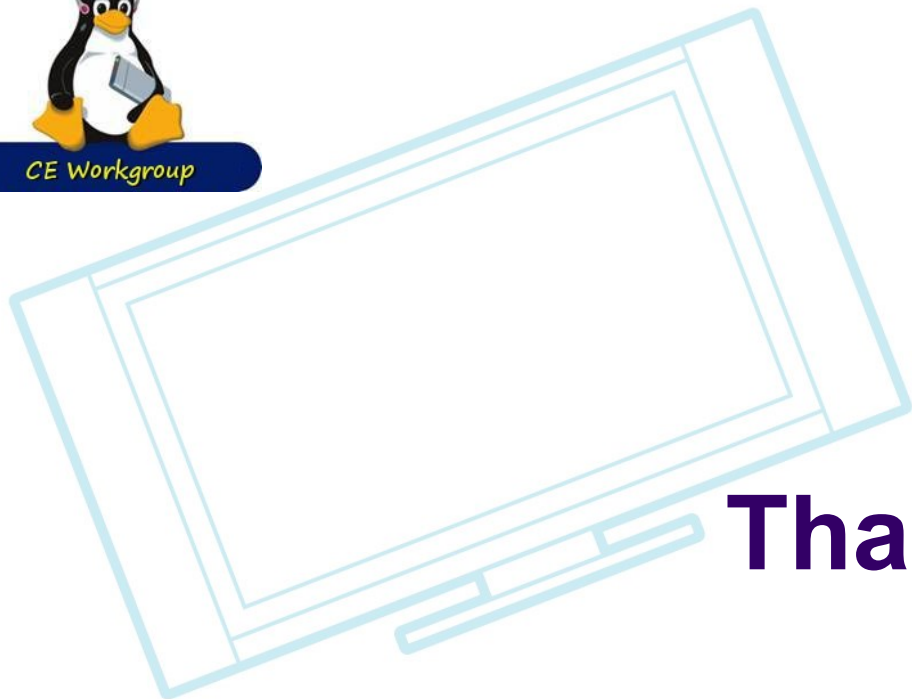
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Resources

- LWN.net – <https://lwn.net>
 - If you are not subscribed, please do so
 - Some content is delayed by 2 weeks for non-subscribers (including links in this presentation)
- Linux.com – <https://linux.com>
- Linux Gizmos – <https://linuxgizmos.com>
- Linux Journal – <https://www.linuxjournal.com/>
- Phoronix - <https://www.phoronix.com/>
- eLinux wiki - <http://elinux.org/>
- Google



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Thanks!

